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Examiner: A. Chambliss
Art Unit: 2827
Docket No.: 52433/545

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : K. TATSUMI et al.

Serial No.: 09/254,119

Filed : April 16, 1999

For : SEMICONDUCTOR DEVICE PROVIDED WITH LOW MELTING
POINT METAL BUMPS

Assistant Commissioner
for Patents
Washington, D.C. 20231

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AMENDMENT

SIR:

Kindly amend the claims of the above-identified
patent application as follows.

Cancel claim 2.

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--16. (Amended) A semiconductor device comprising electrodes formed on a semi-conductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5)

to avoid deterioration of bonding such that the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5);

wherein the metal balls are adhesive bonded to the electrodes with a flux; and

said semiconductor device is to be mounted on a substrate by flip chip bonding wherein the electrodes of said semiconductor device are directly connected to electrode terminals on the substrate through bump material.--

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--17. ~~(New)~~ A semiconductor device comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that at least one of the at least one layer (6, 7) has a thickness which is smaller than that of the electrode material (5) and the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5);

wherein the metal balls are adhesive bonded to the electrodes with a flux; and

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(cont)

said semiconductor device is to be mounted on a substrate by flip chip bonding wherein the electrodes of the semiconductor device are directly connected to electrode terminals on the substrate through bump material.--

REMARKS

Reconsideration of the above-identified patent application, as amended, is respectfully requested. The present amendment is responsive to the Office Action mailed January 15, 2002. A petition for an extension of time in which to respond to the Office Action accompanies this amendment.

By the present amendment, claims 16, 17 and 3-6 are pending in the application. Claims 16 and 17 are the independent claims.

Support For Claim Amendments

Support for --the metal balls are adhesive bonded to the electrodes with a flux-- can be found in canceled dependent claim 2.

Support for --flip chip bonding wherein the electrodes of said semiconductor device are directly connected to electrode terminals on the substrate through bump material-- may be found in the specification at page 1, lines 22 to 25. Page 2, lines 24-28 discloses that the present invention is directed to flip chip bonding.

New matter is not being presented by the present invention.

§102/§103

Claims 2-6 and 16 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,656,863 to Yasunaga et al.

Claim 17 was rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,656,863 to Yasunaga et al. in view of U.S. Patent No. 4,940,181 to Juskey, Jr. et al.

These rejections, as applied to the amended claims, are respectfully traversed.

Patentability

The present invention relates to a semiconductor device (chip) bonded to a substrate by flip chip bonding. In flip chip bonding, electrodes of a chip are directly bonded to electrodes provided on a substrate through a bump.

Yasunaga et al. (U.S. 5,656,863) relates to a rerouted wiring layer of a chip scale package. Referring to Fig. 3 of Yosunaga, the connection layer 8 is used to bond a chip electrode to a rerouted wiring layer. In contrast, the present invention bonds the solder ball (bump material) 3 to the electrode 8. Thus, Yasunaga et al. discloses a technique different from that of the present invention. (See the attached drawing comparing the present invention to Yasunaga and Jurskey).

The connection layer 8 in Fig. 3 of Yasunaga et al., which the Office Action has indicated is made of a metallic material, such as SnPb or InPb, will finally remain as a structural material for the bond between the chip electrode and the rerouted wiring layer. In the present invention, the solder ball 3 is temporarily held on the electrode 8 by a flux, and is then reflowed to form a bump, after which the flux is removed by cleaning. The flux, which is used to hold the ball 3 during the step of the formation of bump and to remove an oxide film on the surface of the electrode 8, is not finally left as part of the bonding structure of the present invention.

In the present invention, the use of flux makes it unnecessary to use the solder (8) and the Cu post (9) which are necessary in Yasunaga et al. The layers 6, 7 in the present invention represent barrier layers to prevent the bump material 3 from staining the electrode material (5), and correspond to the base metal layer 12 in Yasunaga et al. Thus, the layers 6, 7 in the present invention have a function which is entirely different from that of the solder 8 and the Cu post 9 in Yasunaga et al.

A rerouted wiring layer and Cu posts are necessary in chip scale packages, to which Yasunaga et al. pertains, and are not necessary in flip chip bonding, to which the present invention pertains. Flip chip bonding can provide a

package which is more compact compared to a chip scale package.

Juskey (U.S. 4,940,181) relates to the bonding of bumps on a chip to a printed-circuit board. The present invention relates to the bonding of balls (bump material) to electrodes of a chip. (See the attached drawing). The bonded members are entirely different between Juskey and the present invention. The layer thickness disclosed in Juskey are not relevant to the present invention. Combining Juskey with Yasunaga et al. is not reasonable. Even if this combination is attempted, it does not result in present invention or suggest the present invention.

In view of the foregoing, it is submitted that amended independent claims 16 and 17, and claims 3-6 dependent thereon, are patentable over Yasunaga et al. or Yasunaga et al in view of Juskey, Jr. et al.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

The following is a marked version of amended claims 16 and 17.

--16. (Amended) A semiconductor device comprising electrodes formed on a semi-conductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5)

wherein the metal balls are adhesive bonded to the electrodes with a flux; and

said semiconductor device is to be mounted on a substrate by flip chip bonding wherein the electrodes of said semiconductor device are directly connected to electrode terminals on the substrate through bump material.--

--17. (New) A semiconductor device comprising electrodes formed on a semiconductor chip, and bumps each consisting of a spherically formed metal ball having a given size, and adhesive bonded to the electrodes (8) for the attachment of the bumps, wherein each electrode (8) includes

a layer of an electrode material (5) and at least one layer (6, 7) laminated to the layer of the electrode material (5) to avoid deterioration of bonding such that at least one of the at least one layer (6, 7) has a thickness which is smaller than that of the electrode material (5) and the at least one layer (6, 7) has peripheral dimensions substantially the same as or larger than those of the electrode material (5);

wherein the metal balls are adhesive bonded to the electrodes with a flux; and


said semiconductor device is to be mounted on a substrate by flip chip bonding wherein the electrodes of the semiconductor device are directly connected to electrode terminals on the substrate through bump material.--

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended be allowed and passed to issue.

Respectfully submitted,
KENYON & KENYON

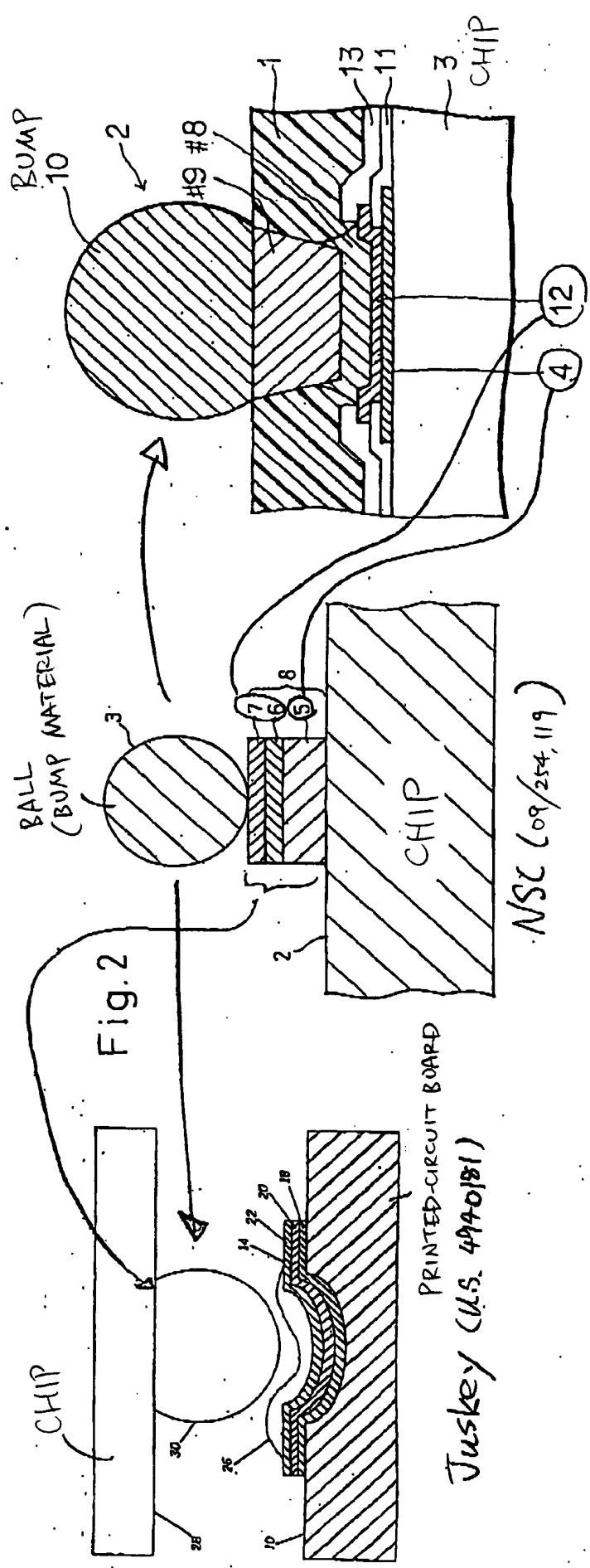
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FIG. 3



Yasukura (U.S. 5656863)

BONDING OF CHIP ELECTRODE (#8) TO COPPER POST (#9) OF REROUTED WIRING LAYER

BONDING OF BALL (BUMP MATERIAL) TO ELECTRODE OF CHIP

BONDING OF CHIP WITH BUMPS TO PRINTED-CIRCUIT BOARD

Juskey (U.S. 4940181)

NSC (09/254,119)